SELECTIVE THINNING

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IT IS WITH some trepidation that I tackle this apparently purely silvicultural subject. I am afraid it may prove of no great interest to the readers of the Chronicle. The trend of thought in our profession has, during the last decade, turned so decidedly towards the logging end, that it is even seriously being considered to throw the appellation of "forester" overboard, substituting it by "logging engineer," and to let our technical society sink down to become a branch of the Engineering Institute of Canada.

In discussions on this subject some writers even made it appear that the title of forester was a hindrance when applying for a job; it would classify the applicant as one of those impractical dreamers who still believed in the possibility of operating Canadian forests on the basis of sustained yield, advocating restrictions and other impractical ideas such as planting, thinning, etc. No! The only way for a forester to justify his existence was to apply himself to the only and all important job of getting out logs cheaply, so that he might be able to reduce the logging costs of his employer.

I shall certainly not quarrel with this branch of the profession; there is undoubtedly an important and well worth while side of it to be taken up, developed and cultivated. Canada certainly needs technically trained logging engineers, but not at the cost of the silvicultural forester. In the old countries where forestry was practised in all its branches before Columbus set sail for America, logging engineering and silvicultural forestry have always gone hand in hand, and it has been proved through the experience of centuries that silvicultural forestry is not alone a necessity, but also paying proposition. I am convinced that a trained forester can benefit his employer just as much by inducing him to operate his forests on silvicultural principles as by helping him to get out logs cheaply, often to the deterioration of the forest.

Let me illustrate this statement by some actual figures. You will find below two sets of empirical yield tables prepared in Denmark and Nova Scotia, where soil and growing conditions are of some similarity. Due to the Gulf Stream the climate in Denmark is a little milder than it is in Nova Scotia. The temperature seldom drops so low in winter, but, on the other hand, does not rise as high in summer. Nova Scotia is located 45 degrees south of the north pole, while Denmark is eleven degrees farther north. The growing period in Nova Scotia is therefore longer than in Denmark. The yield tables are empirical tables prepared from a great number of sample plots of different ages taken in Denmark on the sandy glacial ridges of the island of Funen; in Nova Scotia on glacial deposits, principally in the vicinity of the Annapolis Valley. In Denmark the stands all originated from planting and were therefore pure stands

of Norway spruce; in Nova Scotia the stands selected were pure coniferous stands of a mixture of red spruce and balsam fir found so abundantly throughout eastern Canada on the glacial deposits. Generally the plots were one-half acre in size. They have all been calipered at D.B.H. In each plot two stem analyses have been taken. For these were selected average trees of the average diameter in the plot; a number of heights have been measured in each plot by hypsometer; the age of the plot obtained from the stem analysis has been checked by the increment borer on a number of trees. The different factors making up the total volume have each been computed, in Nova Scotia graphically, in Denmark by established formulas for the different ages.

DENMARK

AFTER THINNING					THE REMOVED TREES				
Age	Number of Trees	Height (feet)	Mean Diameter at B.H. (inches)	Volume (cu. ft.)	Age	Number of Trees	Height (feet)	Mean Diameter at B.H. (inches)	Volume (cu. ft.)
20	3139	24.2	3.0	2274	20	1095	18.2	2.0	252
24	2325	29.3	3.7	2890	24	814	23.3	2.5	356
28	1777	34.7	4.3	3684	28	548	28.7	2.9	429
32	1314	40.0	5.0	4163	32	463	34.0	3.5	587
37	949	47.0	5.9	4833	37	365	41.0	4.2	785
42	682	53.8	6.9	5340	42	267	47.8	4.8	923
48	485	61.8	8.2	6045	48	197	55.8	5.8	1137
54	376	69.5	9.5	6920	54	109	63.5	6.8	954
61	274	78.5	11.0	7514	61	102	72.5	8.0	1406
65	241	82.8	11.9	8174	65	33	76.8	8.8	566
					Total				
					7395				

NOVA SCOTIA

SPRUCE					BALSAM FIR					TOTALS	
Age	Number of Trees	Average Diameter (inches)	Average Height (feet)	Volume (cu. ft.)	Age	Number of Trees	Average Diameter (inches)	Average Height (feet)	Volume (cu. ft.)	Number of Trees	Volume (cu. ft.)
30	865	3.4	23	761	30	720	2.6	24	360	1585	1121
40	645	4.2	31	1161	40	560	3.4	29	616	1205	1777
50	457	5.0	39	1416	50	440	3.8	34	699	897	2115
60	338	5.8	46	1656	60	390	4.2	38	780	728	2436
70	260	6.5	52	1768	70	350	4.5	41	910	610	2678
80	220	7.1	56	1892	80	320	4.7	44	960	540	2852
90	200	7.7	59	2100	90	280	4.8	46	896	480	2996

A comparison of the two tables will show that the number of trees per acre at thirty years were approximately the same. The volume of the stand is somewhat higher in the Danish tables than in the Nova Scotian tables, but in the Danish tables are true volumes; in the Nova Scotian, merchantable volumes. If the Danish tables are reduced by 25 per cent we will find that the difference is not so very great, due, of course, to the fact that the Danish stands have been produced through planting and have been thinned since their

20th year; but, all in all, it can be said that the two stands were somewhat similar. Through thinning the stands the number of trees per acre in Denmark have in their 65th year been reduced to 241, with an average height of 82.8 feet, a mean diameter of 11.9 inches with a merchantable volume of 6,000 cubic feet. They have during that time yielded approximately 5,000 cubic feet in thinned out material. In Nova Scotia the number of trees per acre have by nature been reduced to approximately 650, with an average height of approximately 45 feet and an average diameter of about 5.2 inches, a merchantable volume of 2,557 cubic feet and no yield whatever from thinnings. The Danish forest has during that time produced approximately 11,000 cubic feet of merchantable wood, or 132 cords per acre; the Nova Scotian forest 2,557 cubic feet, or approximately 31 cords of merchantable wood per acre. The Danish forest has been brought to maturity while the Nova Scotian forest is still immature. The Danish forest has produced four and five times as much wood as the Nova Scotian forest, and wood of far superior size and quality. The Danish forest has produced approximately two cords per acre per year, the Nova Scotian forest only one-half a cord per acre per year.

The reader will immediately exclaim: "Bunkum! Let alone the big Danish figures, even the Nova Scotian figures seem unreasonable and far too high. The writer has for 17 years, day out and day in, travelled through the forests of the Maritime Provinces and Quebec and in spite of fires, insect attacks and cutting there are still large areas throughout eastern Canada where pure stands of mixed balsam and fir of the type presented by the yield tables can be found. If the reader will sit down and recollect, go over the forest areas he knows intimately, he will soon be able to enumerate hundreds of square miles of stands of that nature, interspersed here and there in the typical mixed hardwood stands of eastern Canada. I do not hesitate to state that such stands through proper selective thinning could be brought to yield as much as the Danish stands.

One of the first objections of the reader will be: "Are we warranted in spending money on thinning while the danger of fires and insect attacks might wipe out our whole investment?" True, but is Canadian forestry then reduced to a race between forest fires and insects on the one side and the operator on the other. Are these selected, especially well timbered areas not worth a special effort in regard to protection through the construction of fire breaks, towers and storing of fire fighting equipment in their vicinity.

The next objection is our extreme cold in the winter time. The objector will point out that the permanent ice shield in Quebec often is less than a foot below the surface. Quite true, especially in the extremely dense young stands of conifers, where the rays of the sun never reaches the surface. Thinning will perform wonders in these stands. Villyalmur Stefansson in his ar-

ticle, "The Friendly North," states: "The books used to say that in the Northwest Territories of Canada the ground is always frozen and the vegetation poor or absent." But the ground frost really produces an effect just opposite to the one we had expected. A hundred miles south of the Arctic Circle one smart kick with a booted toe reveals in August, ground underneath the warm soil perpetually frozen as hard as granite, but a hundred miles north of the Circle you still find growing on this icy concrete trees of white spruce measured by the Forestry Commissioner of Canada of over seventy feet.

However, the most definite friendliness of the ground ice for vegetation is seen on the prairies north of the forest, for the frost nullifies that yearly variation in rainfall which in most lands is considerable and in some extreme. Plants would die in Australia under rains as scant as those of the Arctic. But in northern Canada when a dry season produces increased heating of the soil, there follows a melting of a little of the ice below so that all the plants have to do to quench their thirst abundantly is to reach with their roots an inch or two deeper than they generally do. There is accordingly neither in Northern Canada nor in northern Siberia any appreciable variation in the productivity of the grasslands between the dry and wet years."

The logging engineer will probably look over these figures, shake his head and exclaim: "Well, after all, cheap logs are cheap logs," and that is more important than embarking upon adventures of theoretical silvicultural profits.

The Scandinavian countries that are able to out-compete Canada on the world's lumber market, to compete successfully with Canada in the United States' newsprint markets have embarked on these adventures and found that they pay. This is due to the following reasons:

A newsprint mill with a daily capacity of 100 to 150 tons will use approximately 70,000 cords a year. A forest treated in a similar manner as indicated by the Danish yield table will produce two cords per acre per annum, in other words, 35,000 acres or 55 square miles should be able to supply the mill with wood ad infinitum. Where the woods department is operating now approximately 2,000 square miles at heavy transportation costs, it would be able to confine its operations to 55 square miles, the operator would be able to construct *permanent* automobile main roads, *permanent* well graded side roads and *permanent* rough snake roads. His logging costs would be reduced many fold, fire protection, insect control, etc. would be reduced to a minimum, and he would be assured of a continuous supply to his mill. I venture to say that every forester of the pulp and paper industry and of the larger lumber industries should be able to pick out a few square miles from the several thousand square miles of limits now under his control, where thinning such as I shall describe below might be practised to advantage. Why not give it a try? Why not start at once? You will be forced into it sooner or later.

Canada has been able to develop a tremendous pulp and paper industry, to dominate the American pulp and paper market, due to her magnificent forest resources; but alas!—cheap wood within easy reach of the mills is becoming scarce. At the same time forestry has developed by leaps and bounds in the United States; the time is not far when American mills, due to forestry, will have cheap wood right at the door yard of their mills. We Canadians will have to follow suit or give up our superiority.

The first thinning should be undertaken when the stand is about 20 years old. This operation is in Europe called "cleaning out." About one third of the trees are cut. First of all the weed trees such as poplar, birch, willow, larch, etc. are cut; then as many trees as possible that have forked trunks or show tendency to become wolves. The thinning must never be so strong that the tips of the branches of adjoining trees can not meet. All the trees cut are left on the ground. Trees with especially heavy crowns are branch-lopped so that they will lie flat. This cleaning out is best undertaken with machetes, brush hooks and shorthanded, broad-bladed axes.

In Europe it is a practical rule that the interval between the thinnings should be one tenth of the age of the stand, e.g. in the forties, four years between the thinnings, in the fifties, five years, etc. Here in Canada I would propose that the first thinning after the cleaning out is undertaken in the thirtieth year.

In order to facilitate the marking of the trees to be removed, and also for reasons to be explained later, I have found the choosing and marking of the final crop trees to be of benefit. From studies here in Canada and experience in the old country I have found that the number of trees the final crop should contain at maturity is for the different species as follows:

Species	Number per acre	Rotation
White pine	200 to 250	80 years
Red pine	250 to 300	80 "
Balsam fir	300 to 400	60 "
Fir and spruce	300 to 400	60 "
Red spruce	250 to 300	60 "
Poplar	150 to 200	60 "
Mixed hardwood	150 to 250	60 "

An acre contains 43,560 square feet. If 200 trees per acre are desired each tree will occupy 43,560 square feet divided by 200, 217.8 square feet; the square root of this, or 14.7 feet is the distance between the trees. At the edge of the selected sample plot one of the dominating trees is selected and marked with a yellow band. By pacing 14.7 feet the most dominant tree within that distance is selected and banded, and so on.

It will be noted that exact figures for the final crop trees are not given in the table. On good soil where each individual tree is strongly developed with heavy trunk and large crown, the number of final crop trees will be smaller than on light or poor soil; although this will be somewhat offset by the fact that the stands on good soil will reach economic maturity earlier than the stands growing on poor soil. Before commencing marking the final crop trees the forester who is to do the marking should therefore take a walk over the area to be thinned and note conditions of the soil and the general growth of the trees, so as to be able to make a decision as to the number of final crop trees desired.

The first step in thinning is therefore the marking of the final crop trees by painting a yellow band around each tree. These trees should constitute the best and strongest developed trees in the stand. The principal object of the thinning is to develop these final crop trees in the best possible way to maturity, not alone so that they contain the highest possible volume, but also so that they have straight, knot-free trunks.

As both spruce and balsam fir keep their dead branches for rather a long period, it might be a paying proposition to prune the final crop trees, but great care should be taken that the bark is not damaged while doing so. Axes can be used for this work, but only in the hands of careful and experienced men. Small pruning saws are better, but the work is slower and more expensive. Bark wounds create flows of pitch which attracts *Pissodes* and bark beetles. The first attack might be drowned out by the tree; next year's attack might, however, succeed and the tree finally die. Furthermore, bark wounds might provide ingress for fungi, especially in the case of balsam fir *Stereum Sanguinolentum*. If pruning cannot be carried out in the proper way, it is better to leave it alone.

At this, the first real thinning, approximately one third of the remaining trees should be removed. They should consist of:

- (1) All the dead and dying trees
- (2) As many of the weed trees as possible
- (3) As many of the wolves as possible
- (4) The whippers, long and very slender trees with a diminutive crown, who in their fight for the light are in the process of being killed by the surrounding stronger trees. These whippers do considerable damage in the stand; the slightest puff of wind will make them sway backwards and forwards, shaving the neighbouring trees and especially in the spring destroying the new tender young shoots and leaves of the trees we want to conserve.
- (5) Trees that are hampering the growth of the final crop trees.

As stated formerly the object of thinning is not alone to obtain the greatest possible volume in the stand but also to produce tall knot-free trunks.

The trees, fighting amongst themselves for sunlight, are by their shade killing the lower branches of their competitors, and in turn, have their own lower branches killed in the struggle. At this first thinning the trees have not yet reached their full trunk height. It is therefore important that there are left sufficient trees in the stand, in order that the lower branches of the crowns be killed, in other words, there must be enough trees left so that they can clean themselves. It is therefore of importance that no big holes are left in the crown cover. Trees adjacent to such a hole will develop low branches reaching into the hole where there is sunlight and will be knotty and probably deformed.

As much as possible of the material cut should be utilized. In the Maritime Provinces and on areas adjacent to the St. Lawrence river, the cut out material can be used as pit props; there is a great, practically unlimited demand for pit props in England. Prices are low, but high enough to pay for the expenses of the thinning. Where thinning is undertaken in the interior and transportation costs of pit props to a harbour too high, utilization of the thinned out material becomes rather difficult. However, the newsprint industry has, during the later years, been satisfied to use pulpwood of fairly small dimensions, and I have no doubt that part of the thinned out material could be used as pulpwood. Some can probably be used as fuel, particularly the weed trees. But, even so, a considerable amount of slash will be left.

The question of slash disposal from the thinnings is difficult. In favour of slash disposal is:

- (1) diminishing of the fire risk
- (2) destruction of breeding places for insect and fungi
- (3) the neater appearance of the forest floor and easier snaking at later thinnings.

Against slash removal is:

(1) protection of the soil. The loam is created by the earth worms and bacteria. These nature's ploughmen eat the fallen leaves; their excrements constitute the loam. Of further importance is the fact that these small ploughmen, through their burrowing in the upper layers of the soil, keep the forest floor porous, enabling the roots to breathe. When the soil, after a thinning, suddenly is left exposed to the sun and wind, the experience has been in the old countries, that these lower organisms, especially on exposed sites, are killed off, greatly to the deterioration of the stand. In order to overcome this difficulty it is therefore the practice in Europe to leave a considerable amount of the slash on the soil as a protective measure.

(2) expense. The burning of the slash after thinning is quite expensive.

I would recommend that all the branches and tops be lopped off and left on the forest floor, while the trunks are sorted in material to be used and material to be burned.

These first two thinnings constitute the real expenditures of the whole process. Later thinnings should pay for themselves through the material taken out.

The next thinnings should be undertaken when the stand is about 37 years old. At this age the final crop trees should about have cleaned themselves out to their final trunk height and the last pruning may be undertaken. The last weed trees and wolves are now removed as the principal object of this thinning is to develop the crowns of the trees. All whippers are therefore cut. About one third of the trees of the stand should be removed. The material from this thinning, the weed trees excepted, should be all of pulpwood size and should produce approximately from 8 to 12 cords to the acre.

When the stand is about 45 years old, it is time for another thinning. At this age the stand has commenced to reproduce itself. The white and red spruce seed generally every fourth or fifth year, the balsam every second year or every year following a favourable year for cone development. Those seed years vary in prolificness with the nature of the preceding year. If the temperature was just right, the moisture sufficient and everything favourable, a big seed year would result. Those seeds would all have excellent germinating power, generally of about 80 per cent, and would develop an excellent second growth if all conditions were right. But if the spring following seed fall was late with successive cold and mild spells an enormous number of the young germinating seedlings would be killed. If the summer was too dry an enormous number of them would die of thirst. If it was too wet the damping off fungus would kill a great number and if the fall commenced too early with heavy frost, the same occurs. In short, if conditions were not absolutely right, there would be no regeneration. When these absolutely right conditions occur, not alone the seeds from the seed year, but also all the stored up seeds in the ground germinate and produce young seedlings. It is a well known fact that spruce seeds will, to a certain extent, keep their germinating power for up to five years. When conditions are right for germinating they sprout together with the newly fallen seeds and create an enormous number of young seedlings.

During the years following this thinning, one of these above described prolific seed years should occur. The principal object of this thinning is therefore to prepare the stand for its reproduction. This cutting becomes what the Germans call the *Verbereitung schlag*, the French *coupe preparatoire*. During the former thinnings the forester will naturally have favored the more valuable spruce tree at the cost of balsam fir. This is further carried out in this

thinning. The dominant spruce trees are given plenty of light so that they will produce cones. About one third of the stand is removed this time, and all the material taken out should be excellent pulpwood. The cutting should produce from 10 to 18 cords to the acre. In order to give the seeds a good seed bed, I consider it advisable to remove nearly all the slash from this cutting. If it is too expensive to burn it, it might be hauled out to the snake roads, branches lopped and left there.

The last thinning should take place when the young stand is about 5 years old. At this cutting all trees but the final crop trees are removed. This cutting can be compared to the German *Besamungsschlag*, French *coupe d'ensemencement*, although I would expect that the next generation already has been established. This cutting should produce from 10 to 20 cords of pulpwood or sawlogs to the acre.

The stand should be mature and ready for cutting when it is 65 years of age. It should then consist of approximately 300 spruce trees, with a balsam fir here and there, evenly distributed over the area, each tree allotted the necessary space for its best development; the trunks should be straight and free of branches, the crown proportion about 0.40. Under the whole stand should be found a dense reproduction.

The final cutting should remove at one cut all the final crop trees, and should produce approximately 70 cords to the acre, principally consisting of even sized logs of good dimensions.

The stand should in this way have produced approximately 30 cords per acre from thinnings and approximately 70 cords per acre from the final crop, and should leave an area well stocked with regeneration.

I have in the above followed a stand from its 20th year to maturity, but thinnings can be taken up at any year in the life of a stand, even when the stand is nearing maturity, when the thinning assures proper reproduction by giving light to the suppressed growth.

The above remarks are the result of seventeen years' study of these questions here in Canada on the background of twelve years' study and experience in forestry in Europe. They are set down for what they are worth, unfortunately not underbuilt by series of research and demonstration cuttings as it has been impossible to carry this out to any great extent here in Canada. However, I may say that I have carried out some work of this nature in the province of Nova Scotia.

The reader may probably exclaim, "Pipe dreams!". However, let me point out that in my article I only refer to pure stands of mixed spruce and fir, and finally, if my article only might result in that somebody would give it a try, then the intention would be fulfilled.